THE MORPHOLOGY AND TAXONOMY OF THE MATURE LARVAE OF THE FAMILY GEOMETRIDAE (LEPIDOPTERA)

BY

KENNETH LEE KNIGHT

B.Ed., Illinois State Normal University, 1937

M.S., University of Illinois, 1939

AN ABSTRACT OF A THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN ENTOMOLOGY IN THE GRADUATE SCHOOL OF THE UNIVERSITY OF ILLINOIS, 1941

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THE MORPHOLOGY AND TAXONOMY OF THE MATURE LARVAE OF THE FAMILY GEOMETRIDAE (LEPIDOPTERA)

This study is the direct outgrowth of the enthusiastic teachings of Dr. William P. Hayes, Professor of Entomology of the University of Illinois, and reflects the increasing amount of atention being shown to the taxonomy of immature insects. To justify the importance of making taxonomic studies of this type, it is only necessary to point out that the principle economic insect damage is caused by the larval stage.

The reasons for selecting the Geometridae were various: first, it is one of the largest of the lepidopterous families; second, the larvae of this family have been studied very little; and third, they represent a group of considerable economic importance. The truth of this latter statement is testified by the fact that in the last few years (since about 1935), the extensive forest insect surveys of the Canadian government have revealed more than twenty species of geometrid larvae as pests of economically important forest trees in Canada.

The direct purposes of the present work were two-fold: (1) To make a complete external morphological study of the mature geometrid larva. (2) To utilize the morphological study for the development of an efficient larval taxonomy.

The External Morphology of the Geometrid Larvae

The study of the morphology of lepidopterous larvae began well over a century ago with the painstaking work of Lyonet, and has continued more or less uninterruptedly to the present. However, due to the improved microscopic methods of recent times, the greatest advances have occurred within the last thirty years. The research of this period has so increased and rounded out our knowledge, that today, a rather complete picture of the lepidopterous larva is available. However, because of the disconnected nature of this work, there is

no single paper in existence which contains a complete description of all of the known external structures of any specific group of lepidopterous larvae. Therefore, a study of the external morphology of the mature geometrid larva was made, partially to attempt such a complete description, and partially to form the basis for an accurate and comprehensive larval taxonomy of the family.

A review of the literature relating to the nomenclature of the body setae was prepared. The Dyar Roman numeral system (1894a), as modified and enlarged by Heinrich (1917), was utilized for the naming of the body setae. The setal arrangement was found to be essential in the diagnosis of genera and species.

The marking pattern of the larva was found to be of great value in taxonomical work once its extensive variations were fully understood. From the examination of many larvae, it was found that each longitudinally-marked species possesses an invariable basic pattern of bands. The troublesome variations which are so commonly met with, are due to the varying amounts of pigment laid down on this basic pattern in different specimens of the same species. The bands only become visible when a sufficient amount of pigment is deposited on them. For the scientific use of the marking pattern as a diagnostic aid, a long series of specimens should be selected and the heaviest pigmented specimen picked out. Then, the elements of this pattern should be charted in their relationships to the positions of the setae, spiracles, and legs. This, then, may be considered as the basic pattern (or near enough so for working purposes) which should be used for the identification of other specimens of the species. In addition, the order of disappearance of the bands should be recorded and used as an integral portion of the chart.

The Taxonomy of the Larvae of the Geometridae

Dr. H. G. Dyar has been the most extensive worker on the larvae of this family, having described over sixty species in the period from 1890 to 1910. However, due to the inadequacy of the knowledge of larval morphology of that period, there

are very few of his descriptions which render it unnecessary to rear the larva again. The same objections may be raised to numerous descriptions by Packard and Forbes. The only keys available to geometrid larvae are those by Forbes (1906) and McGuffin (Brown, 1941), but their use is somewhat limited by the fact that they are based only on color and marking characters.

In the taxonomic portion of this work, the larvae of thirty-two species of geometrids are described in detail. This number includes representatives of all of the six subfamilies. The McDunnough (1938) check list of the Lepidoptera of Canada and the United States lists nearly 1,200 species of geometrids. Of this number, the larvae of approximately 250 have been mentioned in the literature. However, in not over two dozen of these references, is there sufficient descriptive material to make it unnecessary to rear the species again for identification.

The mature instar of each species (except *Brephos infans* Möesch) is uniformly and completely described from reared, preserved specimens. Color notes on the living larva are included wherever possible. The immature larval instars and the egg stage are described where specimens or published descriptions were available.

The description of each species is accompanied with notes (largely from the literature) on economic importance, life history, parasites, food habits, and distribution, along with a rather complete table of measurements.

A larval key was prepared to the six subfamilies of the Geometridae. In addition, keys were prepared for the genera and species included in this study. It was found that none of the published descriptions of geometrid larvae were sufficiently complete to be utilized in the production of keys. Consequently, the keys to subfamilies and genera apply only to the species for which actual specimens were available. In addition, the keys apply only to the last instar larva.

No single character was found to be absolutely diagnostic for all of the geometrid larvae studied. However, the following combination of characters will identify the members of this family without trouble: the possession of only two pairs of

abdominal legs; crochets arranged in a biordinal mesoseries; five or more setae on the sixth abdominal leg below the level of seta *VI*; and the presence of a sub-primary seta (*VIa*) on the pleural area cephalad of *VI* of the first seven abdominal segments.

A List of the Species Described in This Study

Subfamily Brephinae
Brephos infans Möesch
Subfamily Oenochrominae
Alsophila pometaria (Harr.)
Subfamily Geometrinae
Nemoria mimosaria (Gn.)
Synchlora aerata (Fabr.)
Subfamily Sterrhinae
Haematopis grataria (Fabr.)
Subfamily Larentiinae
Calocalpe undulata (L.)
Eupithecia palpata (Pack.)
Eupithecia chagnoni (Swett.)
Hydriomena divisaria (Wlk.)
Eulype hastata (L.)
Subfamily Ennominae
Semiothisa bisignata (Wlk.)
Semiothisa granitata (Gn.)
Semiothisa sexmaculata (Pack.)
Itame ribearia (Fitch)
Itame argillacearia (Pack.)
Paraphia piniata (Pack.)
Protoboarmia porcelaria (Gn.)
Vitrinella pampinaria (Gn.)
Ectropis crepuscularia (Schiff.)
Palaeacrita vernata (Peck)
Erannis tiliaria (Harr.)
Lycia ursaria (Wlk.)
Amphidasis cognataria (Gn.)
Xanthotype sospeta (Fabr.)
Nematocampa limbata (Haw.)
Metarranthis duaria (Gn.)
Ennomos subsignarius (Hbn.)
Pero morrisonarius (Hy. Edw.)
Nepytia canosaria (Wlk.)
Caripeta divisata (Wlk.)
Ellopia fiscellaria (Gn.)
Cingilia catenaria (Dru.)

Larval Key to the Subfamilies of the Family Geometridae

1. Five pairs of abdominal legs present; the first three more or less reduced in size.....BREPHINAE

1- Never more than three pairs of abdominal legs; usually only two pairs.....2

2. Three pairs of abdominal legs present (on fifth, sixth and tenth abdominal segments).....OENOCHROMINAE

2- Never more than two pairs of abdominal legs (on sixth and tenth abdominal segments).....3

3. Spiracles of the second to the eighth abdominal segments tilted dorsad because of being borne on the upper side of prominently out-thrust, dorso-lateral extensions of the body wall; an additional seta is present just below seta *V* of the second and third thoracic segments; the first abdominal spiracle is on a longitudinal line with seta *VI*.....GEOMETRINAE

3- Spiracles of the second to the eighth abdominal segments are not tilted upward by dorso-lateral extensions of the body wall; no adidtional seta just below *V* of the second and third thoracic segments; the first abdominal spiracle is on, or quite near to, a longitudinal line extended through seta *IV*.....4

4. The *F-1* seta is distinctly dorsad of the level of the *A-2* seta of the head.....STERRHINAE

4- The *F-1* seta of the head is on or ventrad of the level of the *A-2* seta.....5

5. The *VII* group of the first five abdominal segments never possesses more than two setae.....LARENTIINAE

5- The *VII* group possesses three setae on the second to the sixth abdominal segments.....ENNOMINAE

SUMMARY

The morphological and taxonomical aspects of the mature larvae of the family Geometridae (Lepidoptera) were studied in detail for thirty-two species. This number included representatives of all of the six subfamilies. Mature larval keys were prepared to the six subfamilies of the Geometridae, and to all of the genera and species considered in the study. The mature instar of each species was uniformly and completely described from reared, preserved specimens. In addition, notes on economic importance, life history, parasites, food habits and distribution were assembled and included. An extensive series of measurements was prepared for each species.

A glossary of terms necessary to the morphological and taxonomical study of the geometrid larvae was prepared.

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VITA

Kenneth L. Knight was born March 16, 1915 in Saunemin, Illinois. He completed the eighth grade at the Eylar rural school in 1928 and graduated from Saunemin Township High School in June, 1932. He received a Bachelor of Education degree in Biology from Illinois State Normal University in June, 1937. In September, 1937, he entered the University of Illinois on a first year graduate scholarship in the Department of Entomology. During the summers of 1938 and 1939, he worked as an Entomological Assistant for the Illinois State Natural History Survey. A Master of Science degree in Entomology was received in June, 1939. The school years of 1939-40 and 1940-41 were spent in the Department of Entomology at the University of Illinois on second and third year graduate fellowships. Since August, 1941, he has been attached to the Malarial Survey Unit at the New River Marine Base in North Carolina with a commission as Ensign in the United States Naval Reserve.